

**Case Study No. 19 Waterborne and UV-Cured Coatings
Riverside Furniture
Fort Smith, AR**

Background

Riverside Furniture produces residential mid-grade and economy furniture. The primary species is oak, although poplar, maple, pine, cottonwood, ash and gum are used. Particleboard, fiberboard, and hardboard also are used to make printed-grain furniture. Riverside also does upholstery work, approximately 15 percent of their business. There are 700 different furniture models currently in production, with the majority as part of a group or overall theme. Turnover to new styles is high, around 25 percent per year. However, this turnover usually applies to pieces within the group, not the theme itself.

Riverside has seven facilities in Fort Smith, Arkansas, and one in Russellville, Arkansas. The Russellville facility is a milling operation, and the seven facilities in Fort Smith include a plywood plant and a research laboratory. Some of the larger plants also have their own mill rooms. Riverside has one million square feet of under-roof manufacturing space. Company-wide, Riverside has 1,400 employees. Riverside replaced some of their coatings with waterborne and UV-curable coatings in the early 1990s in anticipation of being subject to the Wood Furniture NESHAP.

Manufacturing and Coating Operations

Riverside receives mainly raw lumber. The milling operation in Russellville performs cutting and rough shaping of lumber for the smaller facilities, but the larger facilities have their own milling operations. Riverside also purchases some premilled products to finish, mainly chair components. Their end products fall into one of three main production categories: finished wood (70 percent), upholstered (15 percent) and printed-grain (15 percent). The following sections discuss the solid wood and printed-grain finishing operations.

Solid Wood Finishing

Four of Riverside's facilities have finishing rooms. Each finishes a specific range of products. The smallest line finishes assorted small parts from knobs and handles up to chairs and small tables. The next largest is the fastest line and finishes primarily the occasional table line. The next line is a hybrid, finishing some smaller pieces, but also some of the larger pieces. The last, and largest, line finishes the largest pieces, such as wall units, roll-top desks, and headboards. There are 25 different acetone-based stains that currently are in use, in addition to the paints and prints. The following paragraphs describe the coating line in the largest facility, though the steps are similar in all of Riverside's facilities.

All stained furniture is assembled prior to finishing. There are several large areas to stock assembled pieces prior to finishing to allow them to be loaded onto the finishing line with the smallest number of color changes. The finish line is a cart line. The first

spray booth is 80 feet in length. This booth can accommodate six operators with three different stain color lines each, as well as paints in pressure pots. The paints and stains are both applied using HVLP guns. The stain lines are part of a recirculation system. Color changes occur three or four times per day during typical production. The lines are cleaned by blowing air through them to remove the old stain color. If a lighter color will be used next, it also is necessary to run solvent through the lines.



Spray booth

After staining, the carts are conveyed through a forced-air oven to dry the stain (or paint). The pieces then are scuff sanded by hand and a washcoat is applied. This washcoat consists of a 50/50 mix of sealer and thinner and is used to seal the pores in the wood. This coat also is dried in an oven. The next step is to apply filler, which accents the grain of the wood. After drying in an oven, a coat of a high-solids sealer is applied. The sealer is dried in an oven. The last coating step is to apply the high-solids topcoat. Up to two coats are applied, and each is dried in an oven. The washcoat, sealer, and topcoat are all applied using air-assisted airless guns.

Riverside also has a small spray booth off the main cart line which is used to coat smaller products, such as knobs or drawer sides. This helps to alleviate back-ups on the main spray line and is more cost effective than running a cart through the main line with only a few smaller pieces on it.

The cart line now moves through the hardware area where any hang tags and hardware are attached. At the same time, the product is given a thorough inspection. Any pieces with defects in them are pulled off the line and the defect is marked with tape. The product is fixed, on-site if possible. Once the problem is eliminated, the product is put back on the line, where it progresses to the packaging and shipping stations. After being packaged, the cart line leads to a roller line onto which the products are transferred for direct, automated loading into a truck for shipping.

Printed-Grain Products

Riverside also produces a printed-grain finish for their more economical products. These products account for approximately 15 percent of their business. The print room facility employs 30 to 40 people. The finish line is a circular conveyor. The primary substrate is particleboard, although fiberboard and hardboard also are used. All panels have been shaped and edged prior to finishing. The entire printing process takes only 5½ minutes per pass through the line.

The boards are loaded onto the conveyor and first pass through a sander to ensure a smooth finish. The UV-curable filler then is applied and cured by UV lamps. The filler is sanded and a waterborne basecoat is applied. The basecoat is much like a primer for paint applications. The color of the basecoat is matched to that of the final wood grain and it ensures an even, flawless finish. The basecoat is applied by two or three direct roll coaters and dried in a gas-fired oven. The wood grain now is printed by up to three of six consecutive roll coaters. The wood grain is created by applying waterborne ink to an engraved cylinder which then leaves the grain pattern on the board. The waterborne inks dry quickly; there is no need to use an oven. A sealer then is applied as a tie coat if the product will be used as a component in a piece that will receive a topcoat in the finish rooms. If the product's finish is considered complete after the print room, a UV-curable topcoat is applied by a reverse roll coater and cured by UV lamps.



UV oven

Cleaning Operations

Solid Wood Products

All equipment is cleaned with solvents such as acetone. The overhead lines to the main spray booth have reduced necessary cleaning because they can carry three different stain colors simultaneously. When the lines are purged to change stain color, they are blown out with compressed air. The stain is collected in its original container and saved for later use. No solvent is used, except when changing from a dark color to a lighter color.

Printed-Grain Products

Most of the equipment used to apply waterborne coatings can be cleaned using hot water, although the cleaning must be done immediately. If a roll is changed, it must be wiped down immediately to keep the coating from hardening. The engraved rolls for applying the waterborne ink grain must be cleaned with acetone or isobutyl acetate to remove the waterborne coating from the crevices before it hardens.

The roll coater used to apply the UV-cured filler is covered overnight to prevent the coating from being exposed to light and curing, and is cleaned once per week. The topcoat roll coater and coating reservoir are cleaned each night so dust and other particles do not accumulate in the coating overnight.

Conversion to Waterborne and UV-Cured Coatings

Finished Wood Products

The four finish rooms at Riverside have increased the solids content of their coatings and decreased the HAP content. This reformulation necessitated additional operator training because of the differences between the old and new systems. These differences include the higher solids content and different base solvents, which affect the viscosity of the coating. However, since the adjustment was made, the finish is more durable than the old finish. This is due mainly to the better build achieved by the higher-solids product. Riverside is testing spray application of waterborne topcoats, but has not yet achieved the quality they want. Waterborne topcoats that have been tested have produced cloudy finishes and the overspray does not rewet as with conventional lacquer.

Color-matching is a complicated process for Riverside. Not only are they concerned with matching vendors' back-stock of the same product group, matching within the same piece of furniture is a concern. This problem is two-fold. First, the piece is often composed of multiple species of wood, each of which absorbs the color from the stain differently. Second, the piece and/or its components may be finished in several different finish rooms. Riverside makes color standards which catalogue the finish color at each step of the finishing process. These standards are distributed to each finish room to ensure all stock conforms to the same color standards.

The finish rooms also have made reductions in their hazardous waste production. All spray guns have been replaced with HVLP guns, which have a higher transfer efficiency and therefore reduce overspray. Line heaters have been added to adjust the viscosity of the high-solids sealers and topcoats for easier spraying. The coating left in the bottom of the barrels that cannot easily be pumped into the guns also is saved for reuse. The sealer and topcoat bottoms are mixed with solvent and added to new drums. The stain bottoms are combined together to make a "dip stain" that is used to dip parts such as cleats for shelves for which an exact color match is not required because of low visibility.

Another waste reduction activity is gun tip regulation. Riverside found that gun tips were often being used beyond their most efficient ranges, gradually spraying more and more coating as the tip wore out. The operators often did not notice this increase in coating use until the gun actually began to drip coating as it was spraying. Testing showed that the coating wasted by not replacing the tips often enough was far more expensive than replacing the tips on a more regular schedule. Replacing a tip pays for itself in a few days in saved coating. Currently, all guns are regularly tested for efficiency and tips are replaced as soon as they reach the edge of the target zone.

Glaze booth filters have been replaced with a Styrofoam™ product. The new Styrofoam™ product can be dissolved in waste solvent and disposed of. The traditional fiberglass filters had a slight risk of spontaneous combustion due to the linseed oil in the glaze. The Styrofoam™ filters are a new addition, but are working well thus far.

All customer feedback regarding the change has been positive. Their customers have noted the increased durability and enjoy the more resistant finish. The color and clarity also have improved because of the increased attention to the condition of the spray guns.

Printed-Grain Products

More extensive changes were made in the print room. Riverside began researching available coating alternatives in 1990. Several different coating systems were tested before the change to UV-curable fillers and topcoats was made. Riverside tested some waterborne coatings, but they were of inferior quality and therefore unacceptable. Riverside experienced difficulties with grain raise, cloudiness, and the finished pieces sticking together when stacked. Many different coating suppliers were tried, but none could provide the right combination for Riverside.

UV-curable coatings then were explored and solvent-borne UV-curable fillers and topcoats were implemented. Riverside continued to explore other pollution prevention options and replaced the solvent-borne UV-curable filler and topcoat with 100 percent solids UV-curable filler and topcoat. They experienced several problems with the 100 percent solids UV-curable topcoat, most noticeably a “ropiness” to the finish that previously was not present. Riverside was determined that the 100 percent solids UV-curable coatings could be successful, and implemented a new reverse roll coating machine for the topcoat that dramatically increased the quality of the finish.

In 1993, Riverside began investigating waterborne basecoats and inks. There were a multitude of small adjustments that needed to be made to produce a usable product. While each adjustment was minor, the entire process was very time and labor intensive. By 1996, the waterborne basecoats and inks were in full production. Waterborne inks allow the UV-curable topcoat to be applied without the need for a sealer on certain products. For products that still require a sealer, waterborne sealers are being investigated. Products that have been tried to date have caused the finished panels to stick to each other when they are stacked.

Costs

Coating costs have increased 1.5 to 2 cents per square foot coated since the coatings changes have been implemented. While this change may sound minor, with 15 million square feet coated yearly, it quickly turns into a major expense. However, the switch to waterborne coatings also has greatly reduced the amount of solvent cleaner purchased. Taking this reduction into consideration, the increase in cost is minimal. Wood stains have not increased in cost significantly. Any minor cost increases have been offset by the increased coverage of the high-solids coatings and improved application efficiencies. Hidden costs include extensive research and engineering for the air permit modifications which were required to implement many of the improvements.

Emissions

The main pollution prevention efforts began in 1990. From 1989 to 1998, VOC emissions per unit of production have been reduced 22 percent. However, this number is deceptively small. In 1989, the majority of Riverside's business was desks, which are composed of large flat surfaces that are easy to coat with little overspray. Currently, the largest market for Riverside is small occasional tables, which have more smaller parts and therefore a higher percentage of overspray per piece. The VOC

emissions reduction includes a reduction of 100,000 pounds per year of methyl isobutyl ketone (MIBK). The MIBK was used as a cleaning agent for the solvent-borne line, but with the waterborne and UV-curable lines, specialized low-VOC/HAP cleaners are used. During roughly the same time, Riverside reduced HAP use by 65 percent.

Riverside is subject to the Wood Furniture NESHAP and uses an averaging approach. All coatings currently used at Riverside's facilities are compliant with the NESHAP and average less than 0.4 pound of HAP per pound of solids.